

CLAIMS:

1. A catalytic process, comprising:

reacting a reactant with an organometallic catalyst to form a product in a microemulsion comprising the reactant and the organometallic catalyst, and further comprising water, a densified fluid, and a surfactant; and

separating the product from the microemulsion.
2. The catalytic process of Claim 1, wherein the reactant comprises a compound that is a gas at 25°C and one atmosphere.
3. The catalytic process of Claim 2, wherein the reactant comprises carbon monoxide, hydrogen, or a mixture thereof.
4. The catalytic process of Claim 1, wherein the reactant comprises a compound that is a liquid at 25°C and one atmosphere.
5. The catalytic process of Claim 1, wherein the reactant comprises olefinic unsaturation.
6. The catalytic process of Claim 1, wherein the reactant comprises a compound that is a solid at 25°C and one atmosphere.
7. The catalytic process of Claim 1, wherein the reactant comprises a compound that is a liquid at 25°C and one atmosphere and a compound that is a gas at 25°C and one atmosphere.
8. The catalytic process of Claim 1, wherein the organometallic catalyst has a water solubility of at least about 0.001 gram per liter at 25°C and one atmosphere.

9. The catalytic process of Claim 1, wherein the organometallic catalyst comprises a metal selected from the group consisting of Mg, Al, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Ba, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Ra, Ac, Th, Pa, and U.

10. The catalytic process of Claim 1, wherein the organometallic catalyst comprises a metal selected from the group consisting of Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, La, Hf, Ta, W, Re, Os, Ir, Pt, and Au.

11. The catalytic process of Claim 1, wherein the organometallic catalyst comprises rhodium.

12. The catalytic process of Claim 1, wherein the organometallic catalyst comprises a phosphine ligand having a water solubility of at least about 0.1 gram per liter at 25°C and one atmosphere.

13. The catalytic process of Claim 1, wherein the organometallic catalyst comprises a ligand selected from the group consisting of sulfonated aryl phosphines, trialkylammoniumalkyl phosphines, phosphines containing carboxylated aromatic groups and/or side chains, phosphines containing carboxyalkyl groups, hydroxyalkyl-substituted phosphines, trialkylammoniumalkyl-substituted phosphines, phosphines containing phosphonated aromatic groups and/or side chains, carboxy-substituted bipyridines, sulfonate-substituted bipyridines, sulfonated chiral phosphines, carboxy-substituted cyclopentadienes, and mixtures thereof.

14. The catalytic process of Claim 1, wherein the organometallic catalyst has a molecular weight less than or equal to 5,000 atomic mass units.

15. The catalytic process of Claim 1, wherein the surfactant comprises a perhalogenated surfactant, a propylene glycol surfactant, a perhaloether surfactant, a polydimethylsiloxane surfactant, or a mixture thereof.

16. The catalytic process of Claim 1, wherein the surfactant comprises a salt of a fluorinated poly(ether)carboxylate or a fluorinated poly(ether)sulfonate.

17. The catalytic process of Claim 1, wherein the surfactant comprises sodium bis(3,3,4,4,5,5,6,5,7,7,8,8,8-tridecafluorooctyl)-2-sulfosuccinate, sodium bis(2,2,3,3,4,4,5,5-octafluoro-1-pentyl)-2-sulfosuccinate, sodium bis(2,2,3,4,4,4-hexafluorobutyl)-2-sulfosuccinate, or a mixture thereof.

18. The catalytic process of Claim 1, wherein the surfactant comprises a fluorinated analog of sodium bis(2-ethylhexyl)-2-sulfosuccinate in which at least one hydrogen atom is replaced by a fluorine atom.

19. The catalytic process of Claim 1, wherein the densified fluid is a supercritical fluid having a critical temperature less than or equal to 31°C.

20. The catalytic process of Claim 1, wherein densified fluid is a supercritical fluid having a critical pressure less than or equal to 7.4 megapascals.

21. The catalytic process of Claim 1, wherein the densified fluid comprises carbon dioxide, ethane, propane, ethylene, propylene, nitrous oxide, or mixtures thereof.

22. The catalytic process of Claim 1, wherein the densified fluid comprises carbon dioxide.

23. The catalytic process of Claim 1, wherein the catalyzed reaction is selected from the group consisting of hydroformylation, hydrogenation, hydrohalogenation, halogenation, oxidation including hydrocarbon oxidation, carbonylation, decarbonylation, carboxylation, decarboxylation, hydrodimerization, isomerization including olefin isomerization, olefin metathesis, hydrosilylation, hydrocyanation, electrophilic aromatic substitution, arene-olefin coupling, arene-arene coupling, esterification, oligomerization, polymerization, asymmetric arylation, asymmetric allylation, asymmetric hydrogenation, and asymmetric hydroformylation.

24. The catalytic process of Claim 1, wherein the catalyzed reaction comprises hydroformylation.

25. The catalytic process of Claim 1, wherein the microemulsion comprises aqueous emulsion particles having an average particle size less than or equal to 100 nanometers.

26. The catalytic process of Claim 1, wherein the microemulsion comprises at least 1 weight percent water, based on the total weight of the microemulsion.

27. The catalytic process of Claim 1, wherein the microemulsion has a pH of about 2 to about 8.

28. The catalytic process of Claim 1, wherein forming the microemulsion comprises adjusting temperature in the reactor.

29. The catalytic process of Claim 1, wherein forming the microemulsion comprises adjusting pressure in the reactor.

30. The catalytic process of Claim 1, further comprising adding a solvent to the reactor.

31. The catalytic process of Claim 30, wherein the solvent has a water solubility less than or equal to 0.1 gram per kilogram water.

32. The catalytic process of Claim 30, wherein the solvent has a water solubility of at least about 1 gram per kilogram water.

33. A catalytic process, comprising:

adding a reactant to a reactor containing water, an organometallic catalyst, and a surfactant;

adding a fluid to the reactor, wherein the fluid is capable of forming a densified fluid;

forming a water-in-densified fluid microemulsion in the reactor, wherein the microemulsion facilitates a catalyzed reaction of the reactant to form a product;

removing densified fluid from the reactor; and

removing product from the reactor.

34. A catalytic process, comprising:

- 1) charging a reactor with water, an organometallic catalyst, and a surfactant;
- 2) adding a reactant to the reactor;
- 3) adding a fluid to the reactor, wherein the fluid is capable of forming a densified fluid;
- 4) forming a water-in-densified fluid microemulsion in the reactor, wherein the microemulsion facilitates a catalyzed reaction of the reactant to form a product;
- 5) removing densified fluid from the reactor;
- 6) removing the product from the reactor; and
- 7) repeating steps 2) to 6).

35. A catalytic process, comprising:

reacting an olefin, hydrogen, carbon monoxide, and an organometallic catalyst comprising rhodium and trisodium 3,3',3''-phosphinidynetris(benzenesulfonate) in a microemulsion further comprising water, a densified fluid, and a surfactant to form a hydroformylation product; and separating the hydroformylation product from the microemulsion.